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ABSTRACT:

A ferrite loop 21 encircles the line 11 and neutral 12, but not the earth cable 13 of a mains supply. The loop 21 also encircles a further loop 22 which comprises a capacitor 23. The further loop 22 including its capacitor 23 forms a parallel LC circuit which provides a high impedance to signals at the resonant frequency of the LC circuit in a circuit including the neutral and earth cables. The filter has substantially no effect on signals at mains frequency, since the loop 21 encircles both the line cable 11 and the neutral cable 12. There is also disclosed a filtering system comprising two such filters arranged along the arm of a T-filter system, the stem of the T comprising a series LC circuit to provide a low impedance path for signals at its resonant frequency.

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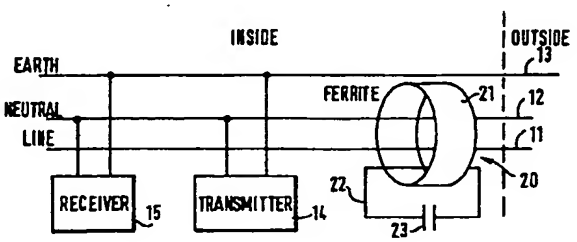
(54) Filtering electrical signals.

(57) A ferrite loop 21 encircles the line 11 and neutral 12, but not the earth cable 13 of a mains supply. The loop 21 also encircles a further loop 22 which comprises a capacitor 23. The further loop 22 including its capacitor 23 forms a parallel LC circuit which provides a high impedance to signals at the resonant frequency of the LC circuit in a circuit including the neutral and earth cables. The filter has substantially no effect on signals at mains frequency, since the loop 21 encircles both the line cable 11 and the neutral cable 12.

There is also disclosed a filtering system comprising two such filters arranged along the arm of a T-filter system, the stem of the T comprising a series LC circuit to provide a low impedance path for signals at its resonant frequency.



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FILTERING ELECTRICAL SIGNALS

This invention relates to filtering electrical signals. When electric cables carry signals of different frequencies, it is often desired to filter out signals of one band of frequencies while leaving substantially uneffected signals in another band of frequencies. The electrical power cables within a building carry electrical currents at mains frequency and these currents travel from the central power station to all the buildings in a given area. The same cables within a given building may be used for carrying communication signals, but those communication signals are only wanted within the given building and should not travel to other buildings or to the central power station where they may cause interference. The present invention can be applied to filtering out signals in the communication frequency band while leaving unaffected signals of the mains frequency.

The cables carrying the mains supply to the building carry high currents and it is dangerous to make connections and disconnections with them while the currents are flowing and yet inconvenient to cut off the mains supply while such connections and disconnections are made. This invention uses a ferrite loop which can be assembled round the cables without having to make connection with them or disconnect the current flow. Further advantages of this are that as the current is in balance at 50 Hz the transformer has no effect on the supply and therefore consumes no power nor disturbs the flow in any way. Ferrite loops are known for use in electrical filters, but not in the particular arrangement of the invention.

According to the invention there is provided an electrical filter for application to electrical cables including a line cable, a neutral cable and an earth cable, the filter comprising a ferrite loop encircling the neutral and line cables but not the earth cable,

the ferrite loop also encircling another loop including a capacitor. Because the current flows through the neutral and line cables are equal and opposite, the net current at the frequency band of the main signals in the neutral and line cables is zero and the filter has substantially no effect on them. The inductance of the ferrite loop electrically connects the capacitor to the neutral wire forming a parallel LC circuit in the neutral cable and the values of the inductance and the capacitor are chosen so that the parallel circuit has maximum impedance at the centre of the frequency band to be filtered out of the cables.

Besides wishing to keep communication signals in the cables within the building from passing out of the building, it may also be desired to keep communication signals in the cables outside the building from entering the building and so a second filter may be provided outside the building. These two filters may form the cross-arm of a T filter, the stem being formed by a series resonant circuit tuned to the same communication frequency so as to provide a very low impedance at the centre of the band of communication frequencies to short-circuit any such communication signals which may have passed through the parallel circuits either from inside or outside the building.

An example of the invention will now be described with reference to the accompanying drawings in which:

Fig 1 is a schematic diagram of a communication system within a building connected to the mains supply and using a filter according to the present invention,

Fig 2 is an equivalent circuit of the filter of Fig 1,

Fig 3 is a further equivalent circuit of the filter of Fig 1,

Fig 4 shows a T-filter arrangement using the filter of Fig 1, and

Fig 5 is an equivalent circuit of the filter of Fig 4.

The mains supply of a building comprises a line wire 11, a neutral wire 12 and an earth wire 13. A communication system within the building comprises a transmitter 14 connected between the neutral wire 12 and the earth wire 13 and a plurality of receivers 15 (only one shown) also connected between the neutral wire 12 and the earth wire 13. The communication system operates at a very much higher frequency than the mains frequency, of the order of 100 kilohertz. A filter 20 is provided where the mains supply enters the building to stop communication frequency signals passing outside the building on the mains cables and also to prevent spurious signals on the mains cables outside the building from interfering with the communication system within the building. The filter 20 comprises a ferrite loop 21 encircling the neutral wire 12 and the live wire 11 and also encircling a loop 22 containing a capacitor 23. The ferrite loop 21 may be made in two or more parts which are fitted together around the neutral and line wires 11 and 12 without the need to break them on assembly of the filter. The earth wire 13 does not pass through the loop 21 and it should be noted that it is the line and neutral wires 11 and 12 which pass through the loop whereas it is the earth and neutral wires 12 and 13 which are used for the communication system.

Fig 2 shows an equivalent circuit of the filter of Fig 1 where the interaction of the neutral wire 12 and the ferrite loop 21 is shown as a single turn 31 in the neutral wire 12 around a core 32 which transfers magnetic flux to a single turn 33 in the capacitor loop 22. The transformer ratio can be altered by providing more than one turn of the loop 22 around the ferrite loop 21.

Fig 3 shows a further equivalent circuit where the transformer coupling the ferrite core 32 brings

the capacitor 23 into a parallel resonant circuit with the inductance of the ferrite loop 21 in the neutral wire 12. The values of the inductance and capacitance are chosen so that the centre of the band of communication frequencies is equal to $(2\pi\sqrt{LC})^{-1}$, where L is measured in Henrys, C is measured in farads and the frequency is in cycles per second. The filter 20 provides a high impedance at the communication frequency where the cables leave the building whereas the impedance between the earth and neutral wires without the filter is fairly low. The communication signals are therefore restricted within the building. The mains current is however unaffected by the loop since both the neutral and line wires 11 and 12 pass through the loop and the net current passing therethrough is zero. A loop which encircles only one of the line and neutral wires 11 and 12 that have a high net current and would therefore have to be built to withstand the high mains current which might be encountered.

In order to prevent communication signals outside the building from entering the building and interfering with the communication system within the building, a second filter can be provided where the cables enter the building to prevent communication frequency signals entering the building. Between the two such filters 20a, as illustrated in Fig 4, a series resonant circuit 20b, also tuned to the centre of the communication frequency band is provided between the earth and neutral wires to absorb signals which may have passed through the ferrite loop filters in either direction. This series circuit can easily be connected without interfering with the main supply by piercing the insulation of the neutral wire and connection to a suitable earth point. Fig 5 shows the equivalent circuit of the T filter of Fig 4. The series resonant circuit 206 has a ferrite core in its coil.

The communication system may use any frequencies outside those used by the mains supply, and a suitable band is 20 kilohertz to 500 kilohertz. The filter of the invention may be applied to any suitable environment, and is not limited to filtering communication signals from mains signals as described in the preferred embodiment above.

The advantage of connecting a communication system to the earth and neutral wires of the mains supply is that in a three-phase distribution system, the communication system extends to all parts of the building to which any phase extends. In a communication system connected between the line and neutral wires, the coverage will only extend to the line wires of the one phase to which the system has been connected. In order to filter signals on a three-phase supply, where three-phase delta connected loads are involved, the three-phase lines plus the neutral must pass through a single encircling ferrite loop so that the current balance at the power frequency is achieved at all times, i.e. different single phase loadings, three-phase balanced loads (no neutral current) and three-phase unbalanced loads. In this way, the three phases could be considered as the live in a single phase circuit and then the filter is electrically the same (although possibly larger) to contain the conductors irrespective of the current passing through them.

In situations where no three-phase delta connected loads are involved, each phase may be separately filtered with a neutral being provided to each phase but a filter as previously described must be used on each phase and neutral.

Claims

1. An electrical filter for application to electrical cables including a line cable, a neutral cable and an earth cable, the filter comprising a first loop including a capacitor and a second, ferrite, loop encircling said first loop and for encircling the neutral and line cables but not the earth cable.

2. A filter system comprising two filters as claimed in Claim 1 and a series resonant circuit tuned to the frequency of signals which are desired to be excluded, for connection between one of the line and neutral cables and the earth cable between the two filters.

3. A filter substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 3 of the accompanying drawings.

4. A filter system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

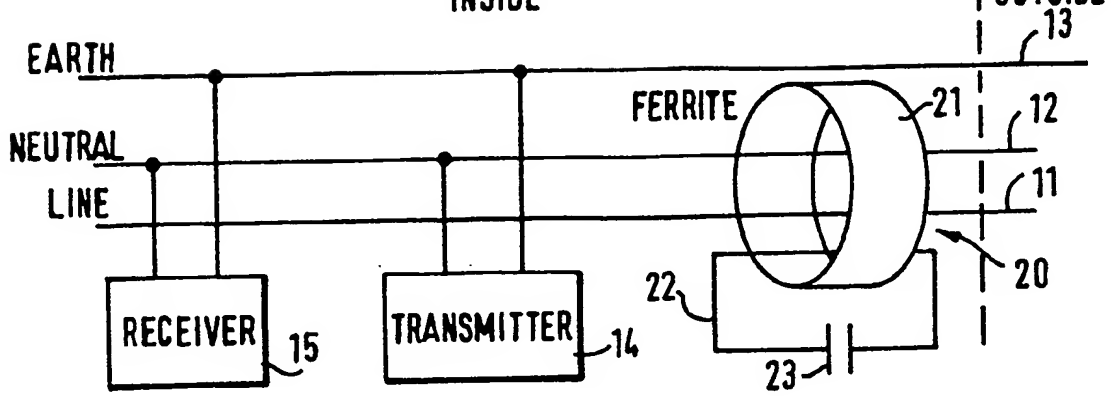

FIG.1.

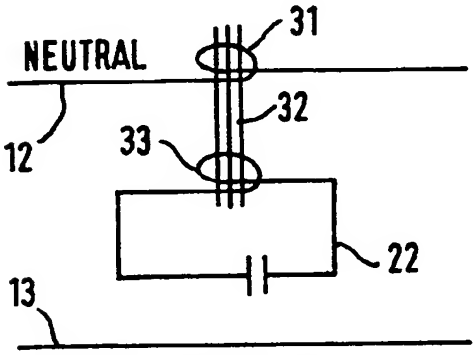

FIG.2.

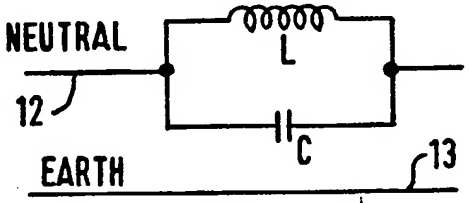

FIG.3.

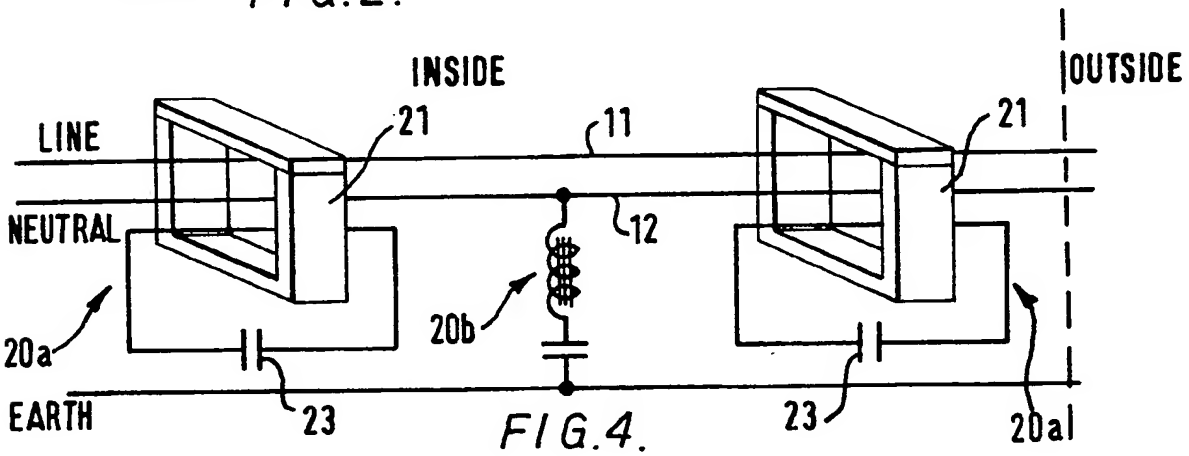

FIG.4.

FIG.5.